Relationship Between Bone Density And Bone Metabolism In Adolescent Idiopathic Scoliosis

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Disclosures:
K. Ishida: None. Y. Ito: None. T. Katsuhata: None. N. Mitsugi: None. Y. Aota: None. T. Saito: None.

Introduction: Although osteopenia is often associated with AIS, bone metabolism in this condition has not been assessed.

Methods: Bone mineral density (BMD) of the lumbar spine and bilateral proximal femurs (dual energy x-ray absorptiometry) and bone metabolism markers [bone formation marker: serum bone alkaline phosphatase (BAP); bone resorption marker: serum tartrate-resistant acid phosphatase serum band 5 (TRAP5b)] were measured in 55 consecutive AIS subjects aged 10 to 18 years-old (mean: 15.6±1.7). BMD, body mass index (BMI), and age of menarche were compared between subjects with normal and high values of TRAP5b.

Results: Nineteen subjects (34%) had osteopenia and 17 subjects (31%) had osteoporosis. In 51 AIS subjects (93%), values for BAP were within normal range, while 33 subjects (60%) had high values for TRAP5b. Subjects with high values for TRAP5b had BMDs of the lumbar spine significantly lower than BMDs of patients with normal values of TRAP5b.

Discussion: The incidence of osteopenia in AIS has been reported to be about 30% (2-6). In our study, 65% of AIS patients were osteopenic or osteoporotic. The higher frequency may be due to the sampling error inherent in our relatively small sample size. Previous researchers reported that low BMD in AIS was associated with delayed menarche (6) and low BMI (13). In our study, the correlation between BMD and age of menarche was not significant. In agreement with a previous report (15), a significant positive correlation between BMD and BMI was found in our study. Bone metabolism in AIS has not been well described. Cheung et al. measured serum concentrations of BAP and urinary concentrations of deoxypyridinoline in 621 AIS patients (7). They reported serum concentrations of BAP in AIS patients from age 13 to 15 years-old were on average 39% higher than those of age-matched controls and that urinary concentrations of deoxypyridinoline in AIS patients older than 15 years-old were 30% lower than those of age-matched controls. They concluded that AIS patients had higher bone turnover because they had 39% higher BAP concentrations. However, their finding that AIS patients had 30% lower deoxypyridinoline concentrations than age-matched controls is not consistent with their conclusion. A limitation of their study was that they used urinary deoxypyridinoline as a bone resorption marker. Urinary deoxypyridinoline has been reported to be more affected by renal function, fasting, and hourly variations than TRAP5b (16). Serum TRAP5b is a biomarker for osteoclastic bone resorption activity and has been reported to demonstrate little daily variation; a low variability of 14% was observed from 09:00-17:00 while urine resorption markers vary as much as 137% throughout the day. TRAP5b also demonstrated minimal response to fasting, a decrease of only 2%, whereas other serum and urine resorption markers decrease 18% during fasting (8).

Although 33 of our AIS subjects (60%) had high values for TRAP5b, only one subject had a high value for BAP. These data suggest there may be high osteoclast activity but normal osteoblast activity and an imbalance in bone metabolism. Examining this imbalance in bone metabolism, Chiru reported that mean RANKL and RANKL to OPG ratios in 15 patients with AIS were increased compared to those in control subjects, suggesting high osteoclast activity and an imbalance in the RANKL/OPG system (17). In our study, BMDs of the lumbar spine were significantly negatively correlated with TRAP5b serum levels; lumbar spinal BMD levels in the high TRAP5b group were lower than those of the normal TRAP5b group. These results mean the main cause of low BMD is increased osteoclast activity as indicated by the high TRAP5b levels. This is the first report describing high values of a bone resorption marker associated with low bone density in AIS patients. A significant relationship between severity of scoliosis and BMD has been reported (5), while another study found no relationship (1). In a histomorphometric study, pinealectomy in broiler chicken model was reported to induce high turnover osteoporosis, which might contribute to the development of scoliosis in the chicken (18). Lu et al. reported that anti-osteoporosis treatment could improve bone strength, prevent osteoporosis and rebalance the OPG- RANK-RANKL system, which might help to prevent curve progression in AIS (19). In our study, the Cobb angle was not associated with BMD or TRAP5b.

Significance: The bone density and metabolism in AIS was high turnover bone metabolism with osteopenia.

Acknowledgments: The authors disclosed no receipt of financial supports.

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**ORS 2014 Annual Meeting**

**Poster No: 0684**